

AMENDMENTS TO THE SPECIFICATION:

Please add the following new paragraph after the TITLE and before STATEMENT REGARDING FEDERAL RIGHTS on page 1:

RELATED APPLICATIONS

This application is a divisional of U. S. Patent application 10/187,024, entitled "Noninvasive Characterization of a Flowing Multiphase Fluid Using Ultrasonic Interferometry," filed June 28, 2002 and incorporated by reference herein.

Please replace the first paragraph of the DETAILED DESCRIPTION on page 5 with the following amended paragraph:

Briefly, the present invention includes apparatus and method for noninvasively monitoring both the flow and/or the composition of a flowing fluid using ultrasound. In what follows, fluid will be defined as a liquid, including liquids with more than one constituent, liquids with some particulates and those containing gas bubbles. As will be described in detail hereinbelow, it was found that the position of the resonance peaks for a fluid excited by a swept-frequency ultrasonic signal change frequency both in response to a change in composition and in response to a change in the flow velocity thereof. Additionally, the frequency difference between successive resonance peaks does not change as a function of flow, but rather in response to a change in composition. Thus, a measurement of both parameters (resonance position and resonance spacing), once calibrated, permits the simultaneous determination of flow rate and composition using the apparatus and method of the present invention. Additional parameters useful for determining the fluid composition include the full-width-at-half-maximum of a resonance feature, the amplitude ratio and the acoustic impedance of the liquid. None of these parameters was found to change significantly as a function of flow rate. The apparatus was tested using decane, dodecane, water, and brine solutions to determine whether these compositions are readily distinguishable using the swept frequency acoustic interferometry (SFAI) technique that has been described in detail for static fluids in U.S. Patent No. 5,767,407 [1] and U.S. Patent No. 5,886,262 [5], the teachings of both references being hereby incorporated by reference herein.

Please replace the second paragraph of the DETAILED DESCRIPTION on pages 5-6 with the following amended paragraph.

Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. Similar or identical structure ~~are~~ is labeled using identical callouts. Turning now to FIG. 1a, a schematic representation of one embodiment of the apparatus of the present invention is shown illustrating a dual-element transducer or two, single-element transducers **10a** and **10b**, located on one side of the pipe or tube, **12**, through which fluid, **14**, flows, and electronics, **16**, provide the fixed or variable acoustic driving frequency, ~~**18**~~, and receive the resonance signal, ~~**20**~~, generated in fluid **14**. FIGURE 1b shows a second embodiment of the apparatus of the present invention showing transmitting transducer **10a** powered by swept sine-wave generator, **20**, on one side of pipe or tube **12** and receiving transducer **10b** in electrical connection with receiving and analyzing electronics, **22**, on the other side thereof. Examples of the circuitry and principles of operation are found in the description for the '232 '262 patent, *supra*. For single-frequency excitation of resonances within the fluid **14**, the change in phase can be monitored by the apparatus. As will be demonstrated hereinbelow, tube or pipe **12** can be fabricated from metals, plastics or glass. FIGURE 1c shows a third embodiment of the present invention, wherein a single piezoelectric transducer, **24**, is used for both generating an oscillatory signal in the sample and for responding to the resonances produced thereby. As is also described in the description for the '262 patent, *supra*, bridge circuit, **26**, is employed to derive a differential signal and includes one arm which contains transducer **24**, a balancing arm which contains a matching or equivalent circuit for the transducer, and a swept sine-wave generator. When the transducer is not attached to the pipe, the output is zero; however, when attached to the pipe, a changing pipe impedance due to standing waves generated therein generates a signal of one arm relative to that of the other arm and the output is the difference between these values.

Please replace the paragraph on page 13, lines 5-9 with the following amended paragraph.

The resolution for sound speed for the SFAI technique of the present invention is approximately $\pm 2\text{m/s}$; this can be improved to 0.1 m/s , if necessary. This difference between decane and dodecane permits them to be identified. Differentiating between water, brine and decane (or dodecane) is ~~straight forward~~ straightforward. The same data are presented in a 3-dimensional graph in FIG. ~~3~~ 4 for clarity.